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Twolined Chestnut Borer

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USDA by George Heaton

Introduction

The twolined chestnut borer, *Agrilus bilineatus* (Weber), belongs to the beetle family Buprestidae. The word "chestnut" refers to the beetle's past status as a principal pest of American chestnut, *Castanea dentata*.

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The twolined chestnut borer is found from the Maritime Provinces of Canada, west to the Rocky Mountains, and south to Florida and Texas (fig. 1).

Hosts

Oaks are the primary hosts of this pest. Some of the more frequently attacked species include white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), northern pin oak (*Quercus ellipsoidalis*), bur oak (*Quercus macrocarpa*), chestnut oak (*Quercus prinus*), northern red oak (*Quercus rubra*), post oak, (*Quercus stellata*),

black oak, (*Quercus velutina*), and live oak, (*Quercus virginiana*).

Adult twolined chestnut borers primarily attack oaks that are damaged by drought or trees that are suppressed or declining. Urban oaks that suffer stress from trunk and root injury, soil compaction, and changes in soil depth are equally vulnerable to attack by this pest. Oaks that have been defoliated by insects such as gypsy moth (*Lymantria dispar*), elm spanworm (*Ennomos subsignarius*), fall canker-worm (*Alsophila pometaria*), and forest tent caterpillar (*Malacosoma disstria*) are also attacked by the twolined chestnut borer.

The twolined chestnut borer adults attack and kill stressed oaks. Other oak borers, such as the red oak borer, *Enaphalodes rufulus*, and the carpenterworm, *Prionoxystus robiniae*, attack live trees without killing them.

Evidence of Infestation

The first symptom of borer attack is usually wilted foliage appearing on scattered branches during late summer (fig. 2). The foliage on infested branches wilts prematurely, turns brown, but remains attached to the branches for several weeks or months

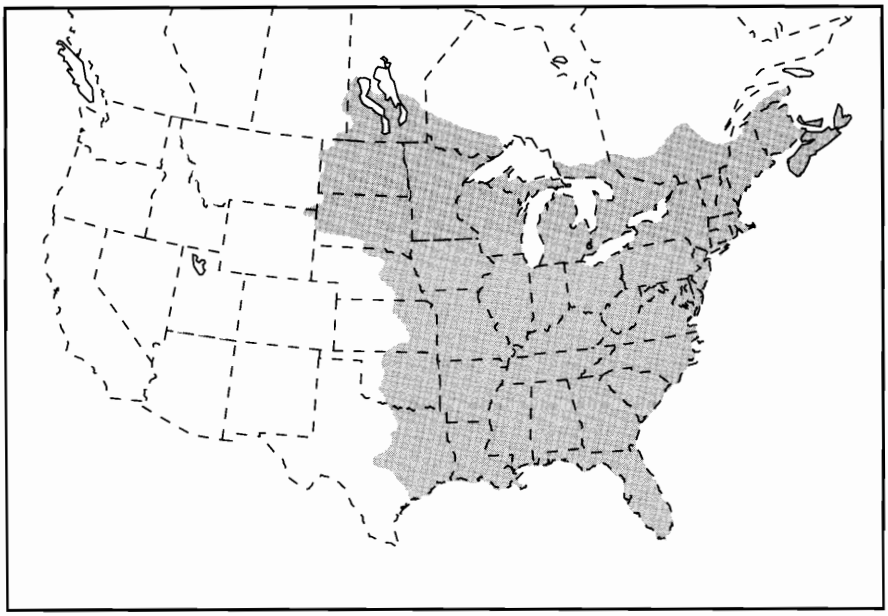

Figure 1—*Probable range of the twolined chestnut borer, based on the combined distributions of its host oak species.*

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Figure 2—*Red oak tree with foliage wilting in late summer—indicative of attack by the twolined chestnut borer.*

Table 1—*Late-summer characteristics of oak trees attacked by twolined chestnut borer (TLCB), where complete tree death occurs over a 3-year period*

Year 1	Year 2	Year 3
Upper crown:		
Foliage wilted, brown	No foliage	No foliage
TLCB larvae common	No TLCB larvae	No TLCB larvae
TLCB galleries common	TLCB galleries common	TLCB galleries common
No TLCB exit holes	TLCB exit holes common	TLCB exit holes common
Other phloem borers rare	Other phloem borers common	Other phloem borers common
Lower crown:		
Foliage healthy, green	Foliage wilted, brown	No foliage
TLCB larvae rare	TLCB larvae common	No TLCB larvae
TLCB galleries rare	TLCB galleries common	TLCB galleries common
No TLCB exit holes	TLCB exit holes rare	TLCB exit holes common
No other phloem borers	Other phloem borers rare	Other phloem borers common
Trunk:		
Foliage, if any, green	Foliage, if any, green	Foliage, if any, brown
No TLCB larvae	TLCB larvae rare	TLCB larvae common
No TLCB galleries	TLCB galleries rare	TLCB galleries common
No TLCB exit holes	No TLCB exit holes	TLCB exit holes rare
No other phloem borers	No other phloem borers	Other phloem borers rare

before dropping. Such branches will die and produce no foliage in the next year.

Trees can be killed in the first year of attack; however, death usually occurs after 2 to 3 successive years of borer infestation. Typically, the crown is attacked during the first year, with the remaining live portions of the branches and trunk being infested during the second and third years (table 1).

Infection by the oak wilt fungus, *Ceratocystis fagacearum*, causes similar symptoms in the tree crown, but the foliage wilts, turns brown, and drops from the branches quickly during early summer.

The twolined chestnut borer leaves a permanent visible record of its visit. As adult borers emerge from the host tree, they bore distinctive D-shaped exit holes 1/5 inch (5 mm) wide in the bark (fig. 3). Exit holes of other oak-infesting wood borers are circular or lens-shaped. For example, exit holes of the adult carpenterworm moth or adult Cerambycidae beetles such as the red oak borer and the rustic borer, *Xylotrechus colonus*, are circular, while those of adult Buprestidae in the genera *Chrysobothris* and *Dicerca* are lens-shaped. Visible D-shaped exit holes indicate that this section of an oak tree

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Figure 3—*D-shaped exit hole of the twolined chestnut borer as observed on the bark surface.*

was infested some time in the past and now is probably dead.

Larvae damage host trees by feeding on the phloem (the inner bark), the cambium (the growth layer producing both phloem and xylem), and the xylem (outer sapwood). The phloem transports food from the crown downward while the xylem conducts water and minerals from the roots upward. Although full-grown larvae are not much thicker than 1/18 inch (1.4 mm), they are able to construct galleries of sufficient depth to cut the flow of food and water. This is especially true for oaks and other ring-porous hardwood species that conduct water almost entirely within the outer one or two growth rings of the sapwood.

Other bark- and wood-boring insects soon colonize portions of the crown and trunk killed by the twolined chestnut borer. For example, the beetles mentioned above that construct circular and lens-shaped exit holes usually colonize the year following attack by twolined chestnut borers. The kinds of insects found beneath the bark help determine how much time has elapsed since the twolined chestnut borer originally invaded (table 1).

Identification of Life Stages

Adult twolined chestnut borers are slender, black beetles, 1/5 to 1/2 inch (5 mm to 13 mm) long with 2 golden stripes along their back (see cover photo).

Adults are active from April to August, depending on the geographic location and temperature. In the Lake States, emergence usually begins in late May to early June and peaks in mid- to late June.

After emerging, adults fly to the crowns of oak trees and feed on foliage before moving to the branches and trunks to mate. Females lay their eggs in small clusters in bark cracks and crevices. Larvae hatch within 1 to 2 weeks.

Larvae are white, slender, about 1 inch (25 mm) long when fully grown, and have two spines at the tip of the abdomen (fig. 4); almost all other wood borer larvae lack such spines. The larvae burrow through the bark to the cambial region. Larvae construct meandering galleries (fig.5) that are packed tightly with frass (feces mixed with boring dust). These feeding galleries cut the flow of food and water in the phloem and xylem.

Larvae go through four instars (forms between molts) between early summer and fall. When fully grown (usually August to October), the larvae burrow into the outer bark and construct individual chambers in which to pass the winter. If the outer bark is thin, the larvae construct chambers in the outer sapwood. Larvae pass the winter in a doubled-over position (fig. 4). Pupation (turning into pupae, a resting stage) occurs the following spring, and adults emerge soon thereafter to renew the cycle.

The twolined chestnut borer produces only one generation per year. However, in rare cases it may take 2 years for some larvae to complete development, especially in the northern extremes of the insect's range, or when

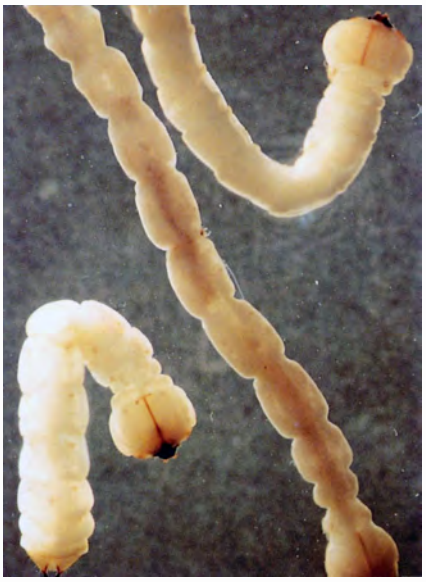

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Figure 4—*Twolined chestnut borer larvae. The center larva represents the type that would be found feeding in the cambial region during late summer. The other two, doubled-over larvae represent individuals taken from their pupal chambers during the winter months.*

developing from eggs laid late in the growing season.

Larvae of the twolined chestnut borer, as well as other members of the family Buprestidae, are called flatheaded wood borers because of the greatly enlarged and flattened first and sometimes second and third thoracic segments (segments of the thorax, the middle of three chief divisions of the insect body). Adult Buprestidae are called metallic wood borers because their ventral (lower) side, and sometimes their dorsal (upper) side, is iridescent or metallic-colored.

Management Techniques

When discussing control strategies for the twolined chestnut borer, it is important to remember that this insect attacks stressed oaks. Recall also that practically nothing can be done to save infested portions of a tree once symptoms become visible, because at that time the damage to the host tree is nearly complete.

Management programs should first attempt to prevent attack from occurring, but if it happens, managers have several control options to use.

Prevention: Thin overstocked stands to increase the vigor of the remaining trees, but use caution to minimize injury to the residual stand. Harvest first the overmature oaks and those of poor vigor. Twolined chestnut borer populations will not build up in logging slash because the material dries too quickly to support larval development.

In residential areas, improve tree vigor by implementing mulching, watering, soil aeration, and fertilization programs. Avoid using lawn fertilizers that contain weed killers near oaks. Use caution during construction and landscaping to avoid soil compaction and damage to roots and trunks.

Natural Control: Larval parasites provide limited natural control of the twolined chestnut borer. One larval parasite, the chalcid wasp *Phasgonophora sulcata* (fig. 6), has caused as much as 10 percent annual larval mortality in Wisconsin.

Downy and hairy woodpeckers, *Picoides pubescens* and *Picoides villosus,* are the two most important predators, feeding primarily on the overwintering larvae. These woodpeckers consumed 78 percent of the larvae from a single white oak tree during one winter in New York State.

Chemical Control: Pesticide treatments can be used to protect high-value shade and ornamental trees. A few pesticides are presently registered with the U.S. Environmental Protection Agency for twolined chestnut borer control: carbaryl, chlorpyrifos, and lindane. Consult you local county Extension Office to determine if changes in pesticide registration have occurred.

To protect standing trees, make the first pesticide application 1 to 2 weeks before adults are expected to emerge. Thereafter, apply two additional sprays at 2-week intervals covering the trunk and branches thoroughly. The first treatment targets emerging adults as they are chewing their way through the bark. The second and third treatments target adults as they mate and lay eggs, the eggs, and the newly hatched larvae.

In addition, infested logs can be treated with approved pesticides. Make a single application to the bark 1 to 3 weeks before adults are expected to emerge. Treat only logs that won't be utilized prior to adult emergence.

It may be necessary to control leaf-feeding caterpillars, like the gypsy moth and the forest tent caterpillar, because severe defoliation can predispose oaks to attack by twolined chestnut borer. Contact your local county Extension Office to learn which pesticides are currently registered.

Photo courtesy of Minnesota Department of Natural Resources

Figure 5—*Typical larval galleries of the twolined chestnut borer as seen on the sapwood surface of an oak tree.*

Cultural Control: Twolined chestnut borer larvae are sensitive to rapid drying of the host tissues. Felling infested oaks during the summer promotes faster drying of the cambial region and can kill the developing larvae. It is critical to fell oaks after most egg laying has ended, but before most larvae have become third instars. In the Lake States, best results occur when oaks are felled during mid-July. Somewhat earlier dates would apply further south. This approach eliminates the need to destroy the infested material quickly because few if any adults will ever emerge.

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Figure 6—*Female (above) and male (below)* Phasgonophora sulcata *adults, common larval parasites of the twolined chestnut borer.*

Pruning is a control option best conducted in late summer when heavily infested branches can be easily identified by foliage that has prematurely wilted. Prune below the last wilted leaves on each infested branch. Burn, chip, or bury the infested material before adults emerge. Proper removal of infested branches during the first year of infestation (table 1), combined with cultural treatments to improve tree vigor, may allow some trees to survive. However, no treatment program can guarantee lifelong protection against future attack by twolined chestnut borer.

From autumn through the following spring, control strategies are aimed primarily at fully grown larvae that are located primarily in the outer bark. For severely infested oaks, like those described in the second or third year of attack in table 1, fell and destroy them before adults emerge. Felling infested oaks from autumn through spring, and even cutting them to firewood lengths, will not greatly reduce borer survival. If possible, remove and destroy the outer bark from currently infested logs; such material will have galleries under the bark (fig. 5), but no exit holes (fig.

3). Destroying the outer bark kills almost all overwintering larvae. The remaining debarked logs pose no further threat from the twolined chestnut borer.

In salvage operations, mark dead and infested oaks in late summer and complete the salvage project before adults emerge the following spring. Prompt removal can lower local borer populations. Make efforts to minimize damage to the residual trees, thereby reducing the number of host trees under stress.

If the infested wood cannot be disposed of prior to adult emergence, place a heavy tarp over the stacked logs or firewood and seal the tarp at the base with soil. Keep it sealed during the entire period of adult activity—May and June in the North, but earlier further south. The adults will emerge and die beneath the tarp.

Remember that once a tree has been killed and the twolined chestnut borer adults have emerged, the tree poses no further threat as a breeding site for this particular beetle. Efforts to reduce local twolined chestnut borer populations should therefore be aimed at currently infested oaks.

Another option is to use trap trees to attract adult twolined chestnut borers. Do this by girdling living oak trees 1 to 4 weeks before adults are expected to emerge, preferably suppressed (smaller or weaker) trees or ones that have been selected for later removal. Note that oaks in the white oak group must be girdled deeper than those in the red oak group to cause death. Adult females are attracted to and lay eggs on girdled oaks, but the larvae will die because the host tissues become excessively dry. Girdle trees close to the ground, because borer larvae can complete development between the groundline and where the tree was girdled.

Assistance

Additional information is available from your State Foresters; Cooperative Extension Agents; and Forest Pest Management, Forest Service, U.S. Department of Agriculture, Washington, DC 20090-6090.

References

Cote, W.A., III; Allen, D.C. Biology of two-lined chestnut borer, *Agrilus bilineatus,* in Pennsylvania and New York. Annals of the Entomological Society of America. 73:409–413; 1980.

Dunbar, D.M.; Stephens, G.R. Twolined chestnut borer: Effects of storage conditions, processing, and insecticides on its survival in oak logs. Journal of Economic Entomology. 67:427–429. 1974.

Dunbar, D.M.; Stephens, G.R. Association of twolined chestnut borer and shoestring fungus with mortality of defoliated oak in Connecticut. Forest Science. 21:169–174. 1975.

Dunbar, D.M.; Stephens, G.R. The bionomics of the twolined chestnut borer. In: J. F. Anderson and H.K. Kaya (eds.) Perspectives in forest entomology. New York, New York. Academic Press. 1976. p. 73–83.

Dunn, J.P.; Kimmerer, T.W.; Nordin, G.L. Attraction of the twolined chestnut borer, *Agrilus bilineatus* (Weber) (Coleoptera: Buprestidae), and associated borers to volatiles of stressed white oak. The Canadian Entomologist. 118:503–509. 1986.

Dunn, J.P.; Kimmerer, T.W.; Nordin, G.L. The role of host tree condition in attack of white oaks by the twolined chestnut borer, *Agrilus bilineatus* (Weber) (Coleoptera: Buprestidae). Oecologia. 70:596–600. 1986.

Haack, R.A. Management prescriptions for the twolined chestnut borer. In: J. Johnson (ed.) Challenges in oak management and utilization: Proceedings of a symposium; 1985 March 28–29. Madison, WI. University of Wisconsin-Madison, Cooperative Extension Service. 1985. p. 42–53.

Haack, R.A.; Benjamin, D.M. Insecticidal control of the twolined chestnut borer, *Agrilus bilineatus* in oak bark in May. University of Wisconsin Forest Research Notes 237. University of Wisconsin, Department of Forestry, Madison, WI. 1980. 4 p.

Haack, R.A.; Benjamin, D.M. Influence of time of summer felling of infested oak trees on larval development and adult emergence of the twolined chestnut borer, *Agrilus bilineatus.* University of Wisconsin Forest Research Notes 236. University of Wisconsin, Department of Forestry, Madison, WI. 1980. 4 p.

Haack, R.A.; Benjamin, D.M. The biology and ecology of the twolined chestnut borer, *Agrilus bilineatus* (Coleoptera: Buprestidae), on oaks, *Quercus* spp., in Wisconsin. The Canadian Entomologist. 114:385–396. 1982.

Haack, R.A.; Blank, R.W. Incidence of twolined chestnut borer and *Hypoxylon atropunctatum* on dead oaks along an acidic deposition gradient from Arkansas to Ohio. In: Proceedings, 8th Central hardwood conference; 1991 March 4–6; University Park, PA. Gen. Tech. Rep. NE-148. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 1991; 373–387.

Haack, R.A.; Benjamin, D.M.; Haack, K.D. Buprestidae, Cerambycidae, and Scolytidae associated with successive stages of *Agrilus bilineatus* (Coleoptera: Buprestidae) infestation of oaks in Wisconsin. Great Lakes Entomologist. 16:47–55. 1983.

Haack, R.A.; Benjamin, D.M.; Schuh, B.A. Observations on the biology of *Phasgonophora sulcata* (Hymenoptera: Chalcididae), a larval parasitoid of the twolined chestnut borer, *Agrilus bilineatus* (Coleoptera: Buprestidae), in Wisconsin. Great Lakes Entomologist. 14:113–116. 1981.

Wargo, P.M. *Armillaria mellea* and *Agrilus bilineatus* and mortality of defoliated oak trees. Forest Science. 23:485–492. 1977.

Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

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